3.—WEST AUSTRALIAN FRESH WATER CALANOIDS (COPEPODA).

I.—THREE NEW SPECIES OF *BOECKELLA*, WITH AN ACCOUNT OF THE DEVELOPMENTAL STAGES OF *B. OPAQUA* n.sp. AND A KEY TO THE GENUS.

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INTRODUCTION.

Boeckella opaqua n.sp., was found in the neighbourhood of York (W.A.). It attracted attention by reason of its bright red colour and its somewhat peculiar habitat, which consisted of a number of small pools of rainwater that collect annually on a smooth granite outcrop, and dry off in the summer and autumn. Further investigation revealed that in the ponds of muddy water lying about during winter in the fields in the vicinity of this outcrop, there was another distinct species of *Boeckella*. Since such an apparently isolated habitat as that of *Boeckella opaqua* might be expected to harbour an unusual form, the species was examined and described. While constituting a distinct species, there is however nothing structurally unusual in it save perhaps the variability of the female fifth leg, which provides further evidence (if any were needed) of the faculty of this genus to produce species. However its discovery provided the opportunity to investigate the life history of a freshwater Centropagid. It was only when this was fully worked out that it was found that Oberg's paper on the development stages of *Centropages typicus* was unobtainable in Australia. Only a brief comparison with other forms has therefore been attempted. In itself the description of a freshwater Centropagid from Western Australia is of importance in being the first account of freshwater Copepoda from this State (with the exception that Professor G. E. Nicholls (1933) has mentioned the report of a *Boeckella* from the Porongorups and of *B. oblonga* (now *B. triarticulata* var. *oblonga* Brehm) from Western Australia); the other *Boeckella* found at York and one found in the grounds of the University are therefore described here as well. For aquatic organisms the South-West of Australia is isolated from the rest of the continent, and it is therefore not surprising that the three species found here should be new ; rather, it is of interest that two of them should be so closely related to species from other parts of Australasia. The discovery is also of interest in view of the fact that this region supports a flora that is the oldest in Australia.

Order CALANOIDA.

Family **CENTROPAGIDAE** Sars, 1902.

Genus **BOECKELLA** DeGuerne and Richard, 1889.

Boeckella opaqua n.sp.

Occurrence.

In shallow granite pools at Woodside, Hamersley (York), throughout the the winter and spring of 1942. Of 72 adults taken on the 22nd of August, 54 per cent. were male.

Colour.

Body, mouthparts, and swimming legs are at all stages heavily pigmented with red, often remaining longest in the spines and setae. All colour disappears in a few days on preservation in formalin.

Female.

Size : 1·26–1·43 mm. (Average of nine specimens : 1·31 mm.).

Head completely divided from thorax and the five thoracic segments distinct. Last thoracic segment produced on either side into a pair of irregular wings, the outermost being the larger and extending on the left nearly to the end of the genital segment, that on the right extending to half the length of the genital segment (Plate II., Figs. 1–3). Rostrum absent. Width of thorax to its length is 1 : 2·4. Abdomen three-segmented, the genital segment being symmetrical or nearly so, with a small irregular ventral swelling ; second segment shorter than anal segment, which in turn is nearly as long as caudal rami. Ratio of abdomen to thorax, 1 : 2·4.

Mouthparts : The mouthparts appear to be typical, but are described and fully figured for comparison with the developmental stages.

First antennae (Plate II., Fig. 1) 25-segmented, reaching nearly to end of genital segment ; proportions of segments 19–25 are 15 : 14 : 13 : 13 : 12 : 11 : 7. Endopod of second antenna (Plate I., Fig. 2) a little shorter than exopod, and its terminal segment bears eight lateral and seven terminal setae. Proximal endopod segment of mandible (Plate I., Fig. 3) bears four setae, and terminal segment eight setae. Epipod of first maxilla (Plate I., Fig. 4) bears nine long plumose setae ; exopod eight setae ; endopod is of four segments bearing six, two, two and the terminal segment four setae; there are two inner lobes each bearing four plumose setae ; gnathobase has the usual stout teeth. Second maxilla (Plate I., Fig. 5) five-segmented ; the first with a lobe bearing three long setae ; second segment with three lobes each bearing two long setae and one shorter, stiffer seta ; third segment has one lobe similar to these ; fourth and fifth segments bear four and two setae respectively. Maxilliped (Plate I., Fig. 6) seven-segmented ; third segment bears three large setae and also a papilla carrying two setae ; fourth segment has three large setae, and the fifth and sixth, two larger setae ; the sixth has also a seta on the posterior margin ; terminal segment bears four setae.

Swimming legs : The general form of the swimming legs (Plate II., Figs. 6–9) is quite typical, but the setation of the second pair is variable as shown by the examination of two specimens of either sex, the setation of the right leg in one instance even differing from that of the left. The seta formula is therefore given with the variations found in the second leg.

	Endopod.	Exopod.
p.1.	1·1·321	1·1·322
p.2.	1·1·422	1·1·422
	1·2·422	1·1·322
	1·2·322	
p.3.	1·2·422	1·1·422
p.4.	1·2·222	1·1·422

The fifth legs (Plate II., Figs. 10–15) also vary in their spines and setae. Ten pairs of legs were examined and the salient features are summarized :

1. The second basipod segment may have an outer plumose seta or not.
2. The first endopod segment may bear an inner seta on the right or left leg, or on neither or on both.

3. The second endopod segment is always unarmed, save for the fringe of fine hairs on its outer margin.
4. The third endopod segment may bear three, four, or five setae, and may be asymmetrical in this respect right and left.
5. The segmentation of the second and third endopod segments may be incomplete.
6. The terminal exopod segment bears on its inner margin two or three spines which vary in length and may be asymmetrical with respect to number and size right and left.

There is a single ovisac containing five to nine eggs.

Male.

Size : 1·00—1·11 mm.

Head distinct from thorax and the five thoracic segments distinct. Last thoracic segment has rounded posterior corners (Plate II., Figs. 4 and 5). Rostrum absent. Width to length of thorax is 1 : 2·6. Abdomen five-segmented : anal segment a little shorter than caudal rami, and nearly twice the length of the fourth segment. Length of abdomen to that of thorax is 1 : 2·6.

Mouthparts : Right first antenna (Plate I., Fig. 1) 23-segmented and geniculate, with spines on segments 8, 10, 11, 12, 18, and 19, and extending back to the end of the furcae : left antenna 25-segmented but not reaching the base of furcae.

Fifth legs (Plate II., Fig. 16) are of usual form, with both endopods two-segmented and no lamella on second basal segment of left leg, though this segment is produced into a rounded prominence that does not reach the distal endopod segment and bears some very small hairs but is not denticulate.

Life History.

Method.—For breeding purposes the specimens were kept in 600 c.c. beakers and in a large round-bottomed jar, the water in these vessels being kept agitated by means of a plunger-jar system as described by Rees and Russell (1938). The Copepods bred freely in these vessels and it was possible to find the nauplii and ova in the beakers quite easily, and these could be captured for examination and dissection ; but it was not possible to follow a single batch of eggs through their life history in such large vessels. Great difficulty was found in keeping the specimens alive when they were transferred to small petrie dishes. The adults would die within three or four days, and although ova would hatch, the resulting nauplii developed very slowly, taking from 27 to 48 hours to go through the first naupliar stage, and afterwards surviving for three days in the second naupliar stage, but none remaining longer alive. Under these circumstances the eggs would take from three and a half to five days to hatch. It seems probable that the water used in these dishes was unsatisfactory. In the beakers and the plunger-jar water taken from the original granite pools was used, but in order to get water free of nauplii for more exact breeding work other water was used. Tap water killed adult Copepods in three or four days, so rainwater from a galvanised iron tank and also rainwater caught in the open in a clean porcelain dish was used, but the result was the same. Both the salinity and pH of the water from the granite pools was found to be that of rainwater, whereas tap water had a salinity nearly three times that of the water from the pools and the pH also was higher. No attempt was made to aerate the water in the small vessels.

After the first week the beaker that had been filled with water from the pools became discoloured with a greenish growth, which proved to be *Euglena*. While no gut is visible in the first nauplius stage, later stages were found to have greenish matter in their gut and this was assumed to be the *Euglena* since no diatoms were present in quantity. A second catch of specimens was made later, and fresh water collected which did not develop this growth of *Euglena*. These specimens were fed on a mixed culture of diatoms obtained by enriching freshly-caught rainwater with Miquel's solutions A and B as described by Allen (1914) for seawater, and inoculating this with detritus from the pools.

THE OVA.

The number of ova in an ovisac varies from five to nine. They are subspherical and 0·115—0·122 mm. in diameter. The eggshell itself is quite colourless, but the eggs appear opaque and granular at all ages on account of their contents which are of the bright red that characterises the adult. They are easy to see lying on the bottom of the beaker, or attached to a female. These ova cannot be resting-eggs for they collapse when allowed to dry up.

THE NAUPLII.

As mentioned above, it was not possible to measure the time taken to pass through the separate stages, but on two occasions a maximum time for the development from the egg to the first copepodid stage was obtained, namely 19 days and 21 days. During this period temperatures of a similar beaker of water standing beside the others were taken at about 9·30 a.m. and 5 p.m. each day ; these temperatures varied from 14·0°C. to 17·4°C. with an average of 15·6°C. Clearly the temperature of the laboratory would be more constant than on the exposed top of a hill, and this would affect the time taken to pass through the developmental stages.

The body and the mouthparts of the nauplii are coloured a bright red like the adult. When first hatched they are packed with red oil globules and no gut is visible, but during stage II. these oil globules disappear and the gut becomes visible.

Difficulty was found in distinguishing the various stages while retaining the specimen still alive, since it is almost impossible to manipulate them with a glass needle without damage, and the differences between some of the stages are such as require special orientation of the specimen if it is to be identified without dissection. In particular it is not easy to distinguish between stages I. and II. and between IV. and V. (see below).

All measurements of the nauplii exclude the caudal setae and spines.

Nauplius Stage I.

Length : 0·158—0·173 mm. (Three specimens).

Very globose, the caudal region smoothly rounded in lateral view and tucked under (Plate III., Fig. 1) bearing two small unequal setae of which the left is the larger ; labrum large and naked, lying closer to the body than in the later stages and therefore less conspicuous ; rostral prominence inconspicuous or absent. A large dark red eyespot present.

First antenna (Plate IV., Fig. 1) : Of three segments ; the first with one ventral, the second with two ventral setae ; terminal segment with three very large plumose setae at its apex which remain most conspicuous throughout all the nauplius stages, being much thicker and longer than any others.

Second antenna (Plate V., Fig. 1) : Coxa with one small masticatory hook; basis with one small masticatory hook and two setae ; endopod with two lateral and two stronger terminal setae ; exopod of five segments, the terminal bearing two setae and the others one each.

Mandible (Plate V., Fig. 7) : Coxa with one small masticatory hook ; basis with two setae showing little or no modification ; endopod with six setae arranged in pairs : exopod of four segments, the terminal bearing two setae and the others one each.

This stage is not clearly distinguishable from the next without dissection, particularly since the first antennae bears the same number of setae. The difference is seen best in side view, when the caudal region of the body is seen to be curved smoothly under, and the somewhat curved labrum to lie along the body. These two features seem to have been impressed upon the larva by the necessity to conform to a spherical eggshell, and they are thrown off at the first moult. In addition to the above differences, stage I. when first hatched is more heavily pigmented or more opaque than other stages and this is often a useful guide, though the opacity goes after a few hours, especially from the first antennae.

Nauplius Stage II.

Length : 0·180—0·190 mm. (Three specimens.)

Still very squat in lateral view (Plate III., Fig. 2) but with caudal region ending bluntly and directed backwards (not ventrally) and with labrum projecting downwards from the body and very conspicuous ; in ventral view (Plate IV., Fig. 8) the posterior region appears rather more elongate and oval, the anterior end somewhat rectangular and with a ventral hyaline rostral prominence ; in this and in all subsequent stages the labrum is clothed at the tip with fine hairs. The eyespot is large.

Throughout the subsequent stages the body becomes more elongated and pyriform rather than oval, the labrum relatively smaller but still very conspicuous in lateral view (in the diagrams of the nauplii from the ventral surface, the labrum appears smaller than it is, owing to its projecting ventrally).

First Antenna (Plate IV., Fig. 2) : As in stage I., but with a number of stiff hairs on ventral margin of terminal segment.

Second Antenna (Plate V., Fig. 2) : Coxa with fine seta and a very strong masticatory hook ; basis with the masticatory hook stronger than before, and two setae ; endopod with two lateral and three strong terminal setae ; exopod as in stage I., but with two setae on the proximal segment.

Mandible (Plate V., Fig. 8) : Coxa with the masticatory hook stronger ; basis with two masticatory hooks ; endopod with eight setae the proximal pair somewhat modified for feeding ; exopod as in stage I., but the proximal segment bears two setae.

Nauplius Stage III.

Length : 0·216—0·230 mm. (Five specimens.)

In this and subsequent stages the head has a very distinctive profile, due largely to the rostral prominence. The caudal region is cleft, each ramus

bearing a stout inwardly curved plumose spine ; interior to this spine and on the dorsal surface of each ramus is inserted a slender seta, the right one usually carried either vertical or lying forwards along the back (Plate III., Fig. 3) and therefore not seen in ventral view (Plate IV., Fig. 9) giving an appearance of asymmetry. The exact point of insertion of these two setae is not clear, but they probably do exhibit a slight asymmetry in this respect. Around the tip of each caudal ramus is a row of fine spinules.

First antenna (Plate IV., Fig. 3) : As in stage II., but terminal segment has an additional ventral and two dorsal setae.

Second antenna (Plate V., Fig. 3) : As in stage II., but coxa with another masticatory hook and basis with three unmodified setae ; endopod with a further lateral and terminal seta ; exopod of six segments, the division between the proximal two being incomplete ; first segment bears two and the terminal three setae.

Mandible (Plate V., Fig. 9) : Coxa showing the rudiments of a mandibular blade ; basis with another masticatory hook ; endopod with seven unmodified setae ; otherwise as in stage II.

Nauplius Stage IV.

Length : 0·246—0·274 mm. (Three specimens.)

The bifurcation of the caudal region deeper, and the spines curved inwards (Plate IV., Fig. 10 ; Plate III., Fig. 4).

First antenna (Plate IV., Fig. 4) : As in stage III., but terminal segment bears three setae on the ventral and four on the dorsal margin ; dorsal margin has also a pair of small hairs.

Second antenna (Plate V., Fig. 4) : As in stage III., but basis carries four unmodified setae.

Mandible (Plate V., Fig. 10) : Blade now well developed, toothed, and carrying a thick plumose seta ; basis with four masticatory spines and two unmodified setae ; endopod with eight unmodified setae arranged in pairs ; exopod as in stage III.

First maxilla (Plate V., Fig. 13) : Present as a bifid lobe bearing 10 setae and taking an active part in the swimming (and no doubt feeding) of the nauplius.

Nauplius Stage V.

Length : 0·280—0·317 mm. (Four specimens.)

The body shows the first indication of the future segmentation of the metasome (Plate III., Fig. 5) : Caudal rami more marked, the spines being divergent. (Some specimens show indications of the second pair of caudal spines that are developed fully in stage VI., placed interior to and a little ventral to the old spines.)

First antenna (Plate IV., Fig. 5) : As in stage IV., but terminal segment bearing four setae on the ventral and six on the dorsal margin ; a tuft of hairs also present on dorsal margin.

Second antenna (Plate V., Fig. 5): As in stage IV., but endopod with four lateral and five terminal setae; exopod of seven free segments, the second bearing four setae and the first none.

Mandible (Plate V., Fig. 11): Blade somewhat larger, otherwise no change.

First maxilla (Plate V., Fig. 14): Of five lobes, the largest showing an incipient division to form another small one; two proximal lobes unarmed, inner lobe carries two, terminal lobe seven, and the outer lobe five setae.

Second maxilla: Consists simply of rudimentary lobe bearing two apical setae.

Nauplius Stage VI.

Length: 0·338—0·372 mm. (Six specimens.)

The incipient thoracic segments are more clearly marked (Plate III., Fig. 6); another smaller pair of caudal spines are borne interior to the old ones (Plate IV., Fig. 12).

First antenna (Plate IV., Fig. 6): Terminal segment bears five setae on the ventral margin and six on the dorsal, with a row of fine hairs at the proximal end of this margin. In some specimens this segment shows an incipient division into five segments.

Second antenna (Plate V., Fig. 6): As in stage V., save for a partial separation of segment two of exopod.

Mandible (Plate V., Fig. 12): As in stage V., save that basis carries one more small seta, and endopod shows a trace of being divided into two segments.

First maxilla (Plate V., Fig. 15): The principal lobes are now clear; epipod bears one seta, exopod six, endopod and its two associated lobes bear 9 + 3 + 3 setae, and gnathobase four setae.

Second maxilla (Plate V., Fig. 16): Of three segments only, though five lobes each bearing two setae are distinct; terminal portion bears three setae.

Maxilliped (Plate V., Fig. 17): Very rudimentary, consisting of three segments, terminal one bearing two setae.

Table I.—The Naupliar Appendages.

First Antenna.

Stage.	1st Segment.	2nd Segment.	3rd Segment.
I.	S	2S	3P
II.	S	2S	3P
III.	S	2S	3P, 3S
IV	S	2S	3P, 7S
V.	S	2S	3P, 10S
VI	S	2S	3P, 11S

Second Antenna.

Stage.	Coxa.	Basis.	Endopod.	Exopod.
I.	M	M, 2S	2S + 2P	P. P. P. P. 2P
II.	M, S	M, 2S	2S + 3S	2P. P. P. P. 2P
III.	2M, S	M, 3S	3S + 4S	2P + P. P. P. P. 3P
IV.	2M, S	M, 4S	3S + 4S	2P + P. P. P. P. 3P
V.	2M, S	M, 4S	4S + 5S	0·4P P. P. P. P. 3P
VI.	2M, S	M, 4S	4S + 5S	0·3P + P P. P. P. P. 3P

Mandible.

Stage.	Coxa.	Basis.	Endopod.	Exopod.
I.	M	2S	6S	S. S. S. 2S
II.	M	2M	2M, 6S	2S. S. S. 2S
III.	M	3M	2M, 7S	2S. S. S. 2S
IV.	M, B	4M, 2S	2M, 8S	2S. S. S. 2S
V.	M, B	4M, 2S	2M, 8S	2S. S. S. 2S
VI.	M, B	4M, 3S	2M, 2S, 6S	2S. S. S. 2S

S = Seta. P = Plumose seta. M = Masticatory hook. B = Toothed mandibular blade.

THE COPEPODIDS.

The development through the copepodid stages is quite typical. All measurements were made to the end of the caudal rami.

Copepodid Stage I.

Length: 0·35—0·45 mm. (Three specimens.)

Thorax five-segmented, and abdomen of one segment only; caudal rami well developed and bearing the full number of setae as developed in the adult, though the outermost terminal seta and the middle one are very short (Plate VIII., Fig. 1).

First antenna (Plate VI., Fig. 1): 11-segmented, the fourth showing indications of subdivisions.

Second antenna (Plate VI., Fig. 5): Already bears all the features of the adult organ, the only change throughout the copepodid stages being in the number of setae on the terminal endopod segment. Coxa bears one seta; basis bears two; first endopod segment bears a pair laterally; second endopod segment bears a tuft of four lateral and five apical setae. Exopod is of the usual seven segments, segments three, four, five, and six being very short; each segment bears one long seta, save the second which has three, and the last, which has three apical setae.

Mandible (Plate VI., Fig. 7): As in the second antenna, this organ has all the adult features developed, the only change through the copepodid stages being an increase in the number of apical setae of the endopod. The blade is well-developed but lacks the seta of the nauplii. Basis bears four setae; first endopod bears four setae laterally, and second endopod six apical setae; exopod is of four segments, each bearing one seta, save the last, which has three.

First maxilla (Plate VI., Fig. 9): This organ is not easy to examine owing to the way in which the lobes overlie one another in the natural condition. However, it seems that all the lobes of the adult organ are present. Epipod bears four long setae and exopod seven setae; endopod is of two distinct segments, the apical bearing four setae and the proximal two pairs of setae—indicating an incipient division.

Second maxilla (Plate VI., Fig. 11): This is of five segments. There are five distinct endites, each bearing two long and one shorter seta, as in the adult; a very small lobe distal to these bears a single seta; the apical segment bears three setae and the sub-apical two.

Maxilliped (Plate VI., Fig. 12): This consists of only four distinct segments, though the third shows an incipient division to four segments. First segment has three (possibly four) protuberances bearing one, two, and three setae; second segment has two setae, the third one, and the apical segment three setae.

The first two pairs of swimming legs only are developed (Plate VII., Figs. 1 and 2), the third pair being rudimentary.

Copepodid Stage II.

Length: 0·52—0·62 mm. (Average of nine specimens: 0·58 mm.)

Thorax of five segments; abdomen shows an incomplete division to two segments; caudal setae are of the same length relative to each other as in the adult (Plate VIII., Fig. 2).

First antenna (Plate VI., Fig. 2): Of 16 segments.

Second antenna (Plate VI., Fig. 6): As in stage I., but both rami are longer and slenderer; in particular the second exopod segment has lengthened; terminal endopod segment bears four lateral and six apical setae.

Mandible (Plate VI., Fig. 8): As in stage I., save that basis is larger and slenderer, the coxa being more clearly marked off; apical endopod segment bears six setae as in stage I.

First maxilla (Plate VI., Fig. 10): All the lobes of the adult organ are clearly present; epipod bears six long setae and exopod seven setae; endopod as in stage I.; there is an increase in the number of teeth on gnathobase.

Second maxilla: As in the adult.

Maxilliped (Plate VI., Fig. 13): Consists of five segments. On first segment are four bulges bearing one, two, two and three setae; second segment has two setae; third segment three setae; the fourth one seta; and the fifth four setae.

First three pairs of swimming legs present (Plate VII., Figs. 3–5), the fourth pair being rudimentary.

Copepodid Stage III.

Length : 0·67—0·75 mm. (Six specimens.)

Abdomen of two distinct segments (Plate VIII., Fig. 3).

First antenna : Of 23 possible segments, but segments two to 10 are very indistinct and probably some of them are incomplete.

Second antenna : As in stage II., but second endopod segment bears five lateral and six terminal setae.

Mandible : As in stage II.

First maxilla : As in the adult.

Second maxilla : As in the adult.

Maxilliped : Consists of six segments. First segment agrees with stage II. ; the second and third bear three setae ; the fourth two ; the fifth one on the anterior and one on the posterior margin ; the sixth four setae. Four pairs of swimming legs present (Plate VII., Figs. 6–9), fifth pair being rudimentary.

Copepodid Stage IV.

Length : Female, 0·83—0·94 mm. (Average of seven specimens, 0·90 mm.)

Male, 0·74—0·80 mm. (Four specimens.)

In dorsal view posterior thoracic corners of female do not appear produced (Plate VIII., Fig. 4) : in side view they are pointed, the points turned downwards. In male posterior thoracic corners rounded. In both sexes abdomen of three segments, the middle one being very short.

First antenna (Plate VI., Fig. 3) : Of 24 segments, though segment four shows a trace of segmentation.

Second antenna : As in stage III.

Mandible : As in stage III.

First maxilla : As in the adult.

Second maxilla : As in the adult.

Maxilliped : Of six segments ; first segment as in the adult ; second segment with three setae ; third segment with four setae ; fourth segment with two setae ; fifth segment with one seta on the anterior and one on the posterior margin ; apical segment has four setae as in the adult.

Four pairs of swimming legs present (Plate VII., Figs. 10–13), and the fifth legs both rami of which in both male and female are one-segmented. In the female (Plate VII., Fig. 18) exopod bears three outer spines, an apical, and three small inner spines ; endopod bears one outer, one apical, and two inner spines ; there is an outer marginal seta on basipod. In the male (Plate VIII., Fig. 9) exopod bears two outer, two apical, and two very small inner spines ; both endopods bear two spines on inner margin near apex, and lower down a minute triangular spine.

Copepodid Stage V.

Length : Female, 1·00—1·08 mm. (Average of nine specimens, 1·04 mm.)

Male, 0·85—1·00 mm. (Average of six specimens, 0·94 mm.)

Female posterior thoracic corners asymmetrical in dorsal view (Plate VIII., Fig. 5), that on the left being the longer ; in lateral view corners pointed and turned down and there is an indication of the future inner lobes either side (Plate VIII., Fig. 6) : abdomen three-segmented. Male posterior thoracic corners rounded (Plate VIII., Fig. 7) ; abdomen four-segmented, the fourth being the longest.

First antenna : In female this is 25-segmented, as in adult. In the male (Plate VI., Fig. 4) the right is of 25 segments with spines on segments eight, 10, 11, 19, and 20, though the spines on the first three of these segments are difficult to distinguish from the setae ; left antenna is 25-segmented.

Second antenna : As in adult, save that endopod bears seven lateral and seven terminal setae, and terminal exopod segment without lateral seta.

Mandible : As in adult, but second endopod segment bears seven setae.

First maxilla : As in the adult.

Second maxilla : As in the adult.

Maxilliped : As in the adult.

Swimming legs have the same setation as the adult (Plate VII., Figs. 14–17). Female fifth legs (Plate VII., Fig. 19) have a two-segmented exopod, the terminal segment bearing the large inner spine not yet fully developed, and in addition three smaller inner spines, an apical and three outer spines ; endopod shows an indication of segmentation into two and bears five spines near its apex ; basipod bears an outer marginal seta. Male right fifth exopod (Plate VIII., Fig. 8) is three-segmented and the left two-segmented, though there are sometimes indications of a division in the second segment ; each exopod bears one long apical spine ; both endopods are two-segmented, that on the right bearing a single subterminal spine.

Table II.—The Copepodid Appendages.

Second Antenna.

Stage.	Coxa.	Basis.	Endopod.	Exopod.
I.	S	2S	2S. 4S, 5S	P. 3P. P. P. P. P. 3P
II.	S	2S	2S. 4S, 6S	P. 3P. P. P. P. P. 3P
III.	S	2S	2S. 5S, 6S	P. 3P. P. P. P. P. 3P
IV.	S	2S	2S. 6S, 6S	P. 3P. P. P. P. P. 3P
V.	S	2S	2S. 7S, 7S	P. 3P. P. P. P. P. 3P
VI.	S	2S	2S. 8S, 7S	P. 3P. P. P. P. P. 3P

Mandible.

Stage.	Coxa.	Basis.	Endopod.	Exopod.
I.	O	4S	4S. 6S	S. S. S. 3S
II.	O	4S	4S. 6S	S. S. S. 3S
III.	O	4S	4S. 6S	S. S. S. 3S
IV.	O	4S	4S. 6S	S. S. S. 3S
V.	O	4S	4S. 6S	S. S. S. 3S
VI.	O	4S	4S. 6S	S. S. S. 3S

Second Maxilliped.

Stage.	Segments number.						
	1.	2.	3.	4.	5.	6.	7.
I.	O, P, 2P, 3P	2P	S				3S
II.	P, 2P, 2P, 3P	2P	2S, S		S		4S
III.	P, 2P, 2P, 3P	3P	2S, S	2S	S, S		4S
IV.	P, 2P, 3P, 4P	3P	2S, S	2S	S, S		4S
V.	P, 2P, 3P, 4P	4P	2S, 3S	3S	2S	2S, S	4S
VI.	P, 2P, 3P, 4P	4P	2S, 3S	3S	2S	2S. S	4S

Discussion.

As mentioned above, Oberg's (1906) paper on the developmental stages of *Centropages hamatus* was not obtainable, nor were Grandori's papers (1912 and 1925) on *C. kroyeri* and *C. typicus*. But Gurney (1931) gives a brief account of the development of *C. hamatus*.

The general form of the nauplius of *Boeckella opaqua* and the stages at which the chief changes take place in the copepodids agree with those for *Centropages hamatus*. The chief difference centres around the male fifth leg. This appears at stage IV. and in *Boeckella* is distinguished from the female by the nearly equally long spines at the apex of the exopod. In the next stage the difference is even more marked, the male legs being considerably modified, whereas in *C. hamatus* they are quite normal (both rami being as yet two-segmented) ; in particular *Boeckella* shows a marked loss of setae from both rami. Thus the whole change to the modified adult condition takes place in the last moult in the case of *C. hamatus*, but is gradually led up to in *Boeckella*—an understandable difference, since *Boeckella* has a fifth leg considerably more modified than *Centropages*. The male prehensile antenna of stage V. seems to agree fairly well in the two species.

Differences in the nauplii are largely due to the more asymmetrical development of the two caudal setae in *Centropages* (though essentially the same structures are present in both), and the absence of setae on the ventral margin of the first antenna of this genus. Both genera agree in having a large rostrum.

A comparison of the male fifth leg in the adult and in copepodid V. makes it clear that the terminal spine of the left leg consists of two terminal exopod segments fused, while the terminal spine on the right consists of the third exopod segment only. Comparing the three stages IV., V., and VI., it is also clear that the development of the two endopods has been retrogressive ; a fact which bears out the theory that the genus *Pseudoboeckella* is older than *Boeckella* (see Marsh, 1924, p. 27). Similarly in the adult female, the presence of fewer inner spines on the third exopod segment, and of fewer terminal spines on the endopod of some specimens is an indication of retrogression in this respect. Finally attention may be drawn to the essential similarity of the fifth legs in both sexes at stage IV.

Bionomics.

The spot where *Boeckella* opaqua was found was the summit of a hill rising about 200 feet above the general level of the plain. On the top of the hill and down one side an exfoliated granite outcrop was exposed, scattered over which in an area of about a quarter of a square mile were numerous pools varying from 12 feet in diameter to mere puddles, and never more than six inches deep. There was sometimes a thin layer of black sediment in these pools, and sometimes some coarse sand, and often nothing, leaving a floor of clean granite. Thick wet pads of moss were everywhere and often these came down to the edge of the water.

Boeckella was found swarming in many of these pools irrespective of size, while from many it was quite absent, or only sparingly found. They could readily be seen mainly around the rim of a pool swimming slowly at the bottom or nearer the surface. If the water was disturbed they would give a number of leaps and then settle down again quickly to their slow swimming action. Associated with them were Cladocera, Ostracods and tadpoles. It is interesting to note in connection with the colouration of this species, that Copepods (especially *Diaptomus*) from high altitudes in the European Alps are supposed to show a tendency to red colouration. Valkanov (1931) summarises two possible explanations : that the red colour is due to feeding, and that it is due to temperature. He dismisses both suggestions, but does not mention the possibility that heavy red pigmentation may be protective against the intense light at high altitudes in shallow pools of clear water. Such an explanation would be suitable here, where the atmosphere is clear even at such slight elevation above sea-level (550 ft.) and where the sun stands considerably higher in the sky than it does in Europe.

The York district is Wandoo country with a rainfall of nearly 20 inches, all of which, except for a few storms in summer, falls between March and October. These pools therefore must be dry for at least three or four months of the year. Though there are frosts in winter, it is unlikely that ice ever forms in the pools, or, if found, remains through the subsequent day. The pH of the pools was calculated from colour charts, using Phenol Red and Cresol Red ; this was found to be 8·0. The salinity was the same as that of rainwater. Since these are rather peculiar conditions, and a different species of *Boeckella* was found in ponds at the ordinary level of the plain, it seems probable that *Boeckella opaqua* has a very limited distribution, probably occurring only in

pools collecting annually in similar granite outcrops in the Wheatbelt. On a visit to the same locality in the previous year the Copepods were present.*

From the breeding experiments it seems unusual for the species to remain alive long after laying its first batch of eggs. There was fairly certain evidence on three occasions that a female produced more than one batch of eggs (as seems to be the rule with most species) but this would not appear to be usual.

Boeckella pellucida n.sp.

OCCURRENCE.

This species was taken at two localities : (1) Five males and 33 females from muddy pools not more than six inches deep, at Woodside, Hamersley (York) August, 1942 ; (2) from a small pond of slightly muddy water less than two feet deep in laterite, by the roadside between Mount Barker and the Porongorups, October, 1942. In the first instance the Copepod was not common while Cladocera were swarming ; in the latter the Copepod was swarming. In both localities the ponds would be dry during the summer.

COLOUR.

Eggs and body pinkish white after preservation in formalin ; when alive, colourless.

FEMALE.

Size : Locality (1), 1·85—2·6 mm. (Average of 11 specimens : 2·0 mm.) Locality (2), 1·5 mm.

Head completely divided from thorax by a faint line ; five thoracic segments distinct, the fifth produced posteriorly to a pair of asymmetrical wings either side, the outermost of which extends on the right side from two-thirds to the end of the genital segment and on the left is always longer than the right and may reach to the end of second abdominal segment (Plate IX., Figs. 2 and 3). Width of thorax to its length, 1 : 2·6. No rostrum. Abdomen, three-segmented ; genital segment large and rather asymmetrical, the right side being more developed at anterior end ; there is a slight ventral prominence. Left caudal ramus usually a little longer than the right and terminal setae short and stout. Length of abdomen to thorax is 1 : 2·2.

Mouthparts : First antennae, 25-segmented and reaching to between the end of the genital segment and the end of the caudal rami ; proportions of last six segments are 17 : 17 : 15 : 15 : 12 : 7. The other mouthparts agree with those figured for *Boeckella opaqua*.

Swimming legs : The seta formula differs slightly from *Boeckella opaqua*.

	Endopod.	Exopod.
P1	1·1·321	1·1·322
P2	1·2·422	1·1·422
P3	1·2·422	1·1·422
P4	1·2·322	1·1·422
P5	0·1·322	1·1·222

Fifth legs (Plate IX., Fig. 6) of usual pattern, and terminal exopod segment bears seven sharp spines, the terminal spine being longer than the segment.

There is a single ovisac containing from 25 to 50 eggs.

* On December 1st and December 20th, 1942, Hamersley had 60 and 100 points of rain respectively. On December 28th, an opportunity was taken to visit the locality and a few of the pools were found to contain still a little water. In all of these there were a few Ostracods and in one case they were swarming ; but there were no Cladocera and no Copepods. This observation would seem to show that the stage in which this species of *Boeckella* resists drought (probably as ova) is not stimulated to continue development simply by a supply of rainwater. Possibly temperature, or the elapse of a time-interval, or a combination of factors, is necessary.

Male.

Size : Locality (1), 1·5—1·6 mm.; Locality (2), 1·4 mm.

Head incompletely divided from thorax, but the fifth thoracic segment distinct and with rounded posterior corners. (Plate IX., Figs. 4 and 5). Width of thorax to its length, 1 : 2·6. No rostrum. Abdomen, five-segmented and its length to that of thorax is 1 : 2·4.

Mouthparts : Right first antenna (Plate IX., Fig. 1) 23-segmented with a spine on segments eight, 10, 11, 14, 15, and two on segments 12 and 16 ; left first antenna, 25-segmented and extending almost to base of caudal rami.

Swimming legs : Their setation agrees with that of the female. The fifth feet (Plate IX., Fig. 7) are of the type of *Boeckella triarticulata* var. *oblonga* Brehm (1939) and *B. fluvialis* Henry (1922). Right endopod is of one segment with a pointed apex and a triangular expansion on its inner basal margin. The right leg differs from *B. fluvialis* in having no pointed process from the second basal segment. Left endopod is clearly two-segmented with proximal segment expanded and distal one rounded at tip. There is a serrate lamella on second basal segment, the inner margin of which is curved (not rectangular as in *B. fluvialis*) and produced apically to a sharp point.

In addition to the differences mentioned above, this species may be distinguished from *B. fluvialis* by the length of the first antennae which never reach the end of the caudal rami, whereas in *B. fluvialis* they extend beyond by two segments at least.

Apart from the two-segmented left endopod, the male fifth legs resemble also *B. triarticulata* var. *oblonga*, but differ in the acute triangular apex of the serrate lamella and in the size of the inner basal expansion of the right endopod. It is clear however that *B. pellucida* is closely related to this species which comes from New South Wales and Victoria.

Boeckella lacuna n.sp.

Occurrence.

A small muddy pond in clay in the University grounds, that dries up in summer.

Colour.

Body hyaline, but at the bases of the limbs there is often some blue pigmentation.

Female.

Size : 1·5—1·7 mm.

The division between head and thorax appears to be incomplete, but the four thoracic divisions are distinct, and the posterior thoracic corners are drawn out into a pair of sharp-pointed lobes either side, the outermost of which are longer and extend to less than half the length of the genital segment (Plate X., Fig. 1). Genital segment very nearly symmetrical ; rest of abdomen typical and the caudal setae rather short and stout. Ratio of thorax to abdomen, 2·4 : 1. Rostrum absent.

First antennae 25-segmented and extending to base or to the end of caudal rami. The other mouthparts agree with those for *B. opaqua* n. sp.

The seta formula for the swimming legs is the same as that of the preceding species. The fifth leg is typical in its general form for the genus, the endopod being fully armed and plumose along its inner margin. The third exopod segment bears seven spines but shows considerable variation in the length of the inner basal spine ; this is most often either as long as the next (as in *B. pellucida* n. sp.) or reduced to the limit shown in Plate X., Fig. 6, intermediate stages are less frequent ; the exopods may be symmetrical or asymmetrical in this respect (seven specimens were dissected).

There is a single ovisac containing about 15 eggs.

Male.

Size : 1·3 mm.

Head entirely separated from thorax, and posterior thoracic corners not produced and in side view appear evenly rounded. Right caudal ramus is somewhat shorter than the left. Ratio of thorax to abdomen, 2·4 : 1. No rostrum.

First antenna is geniculate on the right side, bearing a spine on segments eight, 10, 11, and 17 ; left antenna does not reach the base of caudal rami.

The fifth legs are very similar to *B. pellucida*, differing only in minor features, but principally in the lengths of the endopods relative to the exopod segments and in the lamella on the second basal segment of the left leg, two aspects of which are shown (Plate X., Figs. 7 and 8). Inner margin of first exopod segment of left leg is densely clothed with fine hairs.

Clearly this species is very closely related with the preceding and hence with the *B. triarticulata* group (see below, page 41). It may be distinguished from *B. pellucida* n. sp. by the short posterior thoracic wings which are a constant feature, in conjunction with the slighter and sometimes variable differences in the male and female fifth legs.

The Nauplii.

This species bred freely in the laboratory in a large open porcelain dish and also in petrie dishes and watch-glasses, and all the nauplius stages were obtained. These differed from *B. opaqua* n. sp. only in a few details of the setation of the second antenna and the first maxilla in some of the stages ; in the sixth stage the maxilliped was unsegmented, and from the first appearance of the plumose caudal spines these were more seta-like than spinous. The nauplii were colourless. Apart from these differences the nauplii in their general form and in their appendages were strikingly like those of *B. opaqua*, as appears to be the rule with species of the same genus.

A NOTE ON THE DISTRIBUTION OF *BOECKELLA*.

The geographical distribution of this genus is perhaps its most interesting feature. *Boeckella* and *Pseudoboeckella** are found in Kerguelen and New Amsterdam Islands, Australia, Tasmania, New Zealand, South America, and one species in Mongolia (Sars, 1903, and Kiefer, 1937). In fact the genera seem to fill for South America and Australasia the same position that *Diaptomus* does for the Northern Hemisphere. In other words we are faced with the old problem of a distinctive Australasian fauna allied to that of South America and islands in the Indian Ocean but not to South Africa. In addition it appears that *Boeckella* and *Pseudoboeckella* are confined to temperate

* The separation of the two genera is convenient rather than natural, being based on the degree of reduction of the right fifth endopod of the male, an organ that is clearly undergoing a gradual process of reduction.

regions ; this is indicated by their distribution in Australia (though little investigation has been done in the sub-tropical regions) and in South America, where Patagonia and southwards is the main area for *Boeckella* and *Pseudoboeckella*, the genera extending northwards only along the chain of the Andes. The temperate distribution of these Copepods is important in showing that whatever Australia's connection with South America may have been, it was (at that time) in temperate latitudes. It may be argued that *Boeckella* does not extend into the tropics because of the competition of *Diaptomus* (found throughout the South American tropics and in the Malay Archipelago) ; we know, however, that *Diaptomus* thrives in a temperate climate, so that conversely *its* migration southwards would appear to be hindered by the competition of *Boeckella*. In Australia itself only three species of *Diaptomus* were recorded by Henry in 1922, and none were found south of 28° 50′ south.

A further interesting point has been touched on by Nicholls (1933), namely, that the Cladoceran genus *Daphniopsis* has been recorded only from this State, Kerguelen Island, and Mongolia, and that this distribution is paralleled by that of *Boeckella*. He says (p. 124) that *B. oblonga* Sars (now *B. triarticulata* var. *oblonga* Brehm) which is very similar to *B. orientalis* Sars (the Mongolian species of *Boeckella*) has been found in Western Australia, but this report has not been published and was possibly a mistaken identification ; nevertheless weight is given to the general argument by the establishment (see below), of very close affinities in a group of species and varieties which includes *B. orientalis* and two species from this State. This provides some evidence that the Mongolian colony of *Boeckella* was carried thither from Western Australia rather than from other parts of this continent.

A KEY TO THE GENUS *BOECKELLA*.

Since the publication of Marsh's key in 1924 seven new species (exclusive of those described in this paper) have been created, and four varieties ; it is therefore of some use to bring this key up to date. The task of making a key is rendered more difficult by the marked tendency for species of this genus to vary even within a single local colony, and also the inadequate figures and descriptions supplied for some of the species. One species only however, has for this reason been omitted from the revised key, namely *Boeckella major* Searle (1938) from Victoria (Australia). This species may probably be recognised by its large size (♀ : 3·35 mm., ♂ : 2·75 mm.) and large posterior thoracic processes which extend almost to the third abdominal segment. This is all the description supplied ; in addition there is a figure of the male fifth legs showing a three-jointed right endopod, the left endopod being wanting.

Brehm (1939) tabulates some characteristics from two descriptions of *B. triarticulata* Thomson for comparison with those of *B. oblonga* Sars and a new variety of *triarticulata*. He reaches the conclusion that, retaining the name *triarticulata* for one of these forms, the other three must be regarded as varieties of it (the name *B. oblonga* Sars therefore lapses in favour of *B. triarticulata* var. *oblonga* Brehm). It seems best to accept these varieties, at least until it can be shown that they are not constant. In the species *triarticulata* we are faced with what seems to be a widely distributed and variable group of forms, since its varieties are found from New Zealand to New South Wales and South Australia, and the two new species *B. pellucida* and *B. lacuna* described in this paper from Western Australia (and possibly *B. orientalis* Sars from Mongolia) are closely related to it. Specific rank has been given to the Western Australian forms since in both cases the description was made from a number of individuals, and in the case of *B. pellucida* distinguishing

characters were found constant in two widely separate localities. Nevertheless *B. triarticulata* Thomson and its three varieties *Sarsi*, *oblonga* and *quarta*, with *B. pellucida* and *B. lacuna* n. spp. and *B. orientalis* Sars form a group in which species can be separated only by the combinations taken by various characters that are evidently readily varied in the group's evolution.

Brehm (1937) criticises Marsh for using the segmentation of the endopod of the male fifth leg as a character on which to base his key, saying that the segmentation here is frequently difficult to determine, and in one form (*B. bergi* var. *cornuta*) is incomplete. The variability in the number of spines on the exopod segment of the female fifth leg in *B. opaqua* n. sp. renders this feature also of doubtful value and emphasises the unreliability of descriptions made from only one or two specimens of a species. To alter these points, however, would have meant recasting the whole key, and this was not thought worth while in view of the difficulty of obtaining literature.

KEY.

1. Terminal exopod segments of female fifth legs with two spines	*minuta* Sars (1896).
Terminal exopod segments of female fifth legs with three spines	2
Terminal exopod segments of female fifth legs with five or six spines	11
Terminal exopod segments of female fifth legs with seven spines or setae	12
2. Right endopod of male fifth leg one-segmented	3
Right endopod of male fifth leg two-segmented	4
Right endopod of male fifth leg three-segmented	5
3. First antennae reach to second abdominal segment ; right endopod of male fifth leg very short, digitate	*gracilis* Daday (1902).
First antennae reach to end of furca ; right endopod of male fifth leg equals the first two exopod segments, is pointed and curved inwards	*occidentalis* Marsh (1906).
4. First antennae reach to end of furca; last thoracic segment of female is slightly produced; left endopod of male fifth legs one-segmented ...	*gracilipes* Daday (1901).
First antennae reach the end of the furcal setae; thoracic processes of female reach the end of the first abdominal segment ; left fifth endopod of male two-segmented	*poopoensis* Marsh (1906).
5. Thoracic processes in female very asymmetrical, the right one reaching to end of genital segment, the left reaching to half way down the second abdominal segment	*rahmi* Brehm (1935).
Thoracic processes in female extend to an equal distance left and right	6
6. Thoracic processes reach less than half the length of the genital segment	7
Thoracic processes as long or longer than the genital segment	8
7. First antennae of female do not reach the second abdominal segment; terminal spine of male right fifth leg sickle-shaped	*meteoris* Kiefer (1927).
First antennae of female extend to or beyond the furca ; terminal spine of male right fifth leg but slightly curved	*michaelseni* Mrazek (1901).

8. Inner margin of second segment of male right fifth leg concave ; thoracic processes reach the end of the genital segment ... ... *dentifera* Brehm (1935).
The inner margin of this segment convex ; thoracic processes reach to the second or third abdominal segment 9

9. Inner margin of this segment with a hooked knob *bergi* var. *cornuta* Brehm (1937).
Inner margin smooth 10

10. Second basal segment of male left fifth leg bears a sharply triangular serrate lamella at its inner distal corner ... ... *bergi* var. *serrifera* Brehm (1937).
The corner of this segment smooth ... ... *bergi* Richard (1897).

11. First antennae reach to half the length of the furcal setae ; right fifth endopod of male one-segmented ... ... *insignis* Smith (1909).
First antennae reach to half the length of the genital segment ; right fifth endopod of male two-segmented ... ... *opaqua* n. sp.
First antennae reach to the furca ; right fifth endopod of male is three-segmented ... *Hemiboeckella searli* Sars (1912).

12. Right endopod of male fifth leg one-segmented 13
Right endopod of male fifth leg two-segmented 22
Right endopod of male fifth leg three-segmented 23

13. Inner margin of second basal segment of left fifth leg of male serrate ; but with no lamella ; the left endopod irregularly curved ... *coronaria* Henry (1922).
Inner margin of this segment with a rather prominent serrate lamella 14
Inner margin of this segment bears a lamella that is not serrate and is about equal in length to the endopod ; endopod of right leg extends beyond the second exopod segment ... *ambigua* Percival (1937).
Inner margin of this segment not serrate and bearing no serrate lamella 18

14. Left endopod of male fifth leg two-segmented 15
Left endopod of male fifth leg one-segmented 16

15. Second basal segment of right male fifth leg smoothly rounded ; left endopod reaching half-way up the first exopod segment ; first antennae do not reach the end of the caudal rami ... ... *pellucida* n.sp.
Second basal segment of right male fifth leg smoothly rounded : left endopod reaching to the end of the first exopod segment ; first antennae do not reach beyond the end of the caudal rami ... ... *lacuna* n.sp.
Second basal segment of right male fifth leg produced into a triangular process ; first antennae extend beyond the caudal rami by at least two segments ... ... *fluvialis* Henry (1922).

16. Terminal spine of right male fifth leg sickle-shaped ; left inner lobe of thoracic processes acute, right one rounded ... ... *orientalis* Sars (1903).
Terminal spine of right male fifth leg broad in its basal half and abruptly narrowed at about the mid point ; both inner lobes of thoracic processes acute, the outer lobes reaching to the anal opening ... ... *triarticulata* var. *quarta* Brehm (1939).

Terminal spine of right male fifth leg but slightly curved and tapering evenly ; both inner thoracic lobes acute, not reaching to the anal opening 17

17. Thoracic processes do not reach the end of the genital segment ; right endopod of male fifth leg reaches the end of the second exopod segment ... ... *triarticulata* var. *oblonga* Brehm (1939
Thoracic processes reach the end of the genital segment ; right endopod of male fifth leg does not reach the end of the second exopod segment *triarticulata* Thompson (1883).
Thoracic processes reach beyond the genital segment ; right endopod of male fifth leg reaches the end of the second exopod segment ... *triarticulata* var. *sarsi* Brehm (1939).

18. Left endopod of male fifth leg short 19
Left endopod of male fifth leg nearly equals the first exopod segment in length 21
Left endopod of male fifth leg is wanting ... *asymmetrica* Searle (1914).

19. Terminal spine of right male fifth leg stout and suddenly constricted in the last sixth of its length ... ... *hamata* Brehm (1928).
Terminal spine evenly tapered 20

20. Right endopod of male fifth leg does not reach halfway up the second exopod segment ; second basal segment of this leg produced at the inner distal corner into an acute spine ... *rubra* Smith (1909).
Right endopod reaches at least two-thirds the length of the second exopod segment, and carries near the base on the inner margin a spine ; second basal segment rounded ... *robusta* Sars (1896).

21. First antennae of female reach the furca ; thoracic processes short and turned out ... *symmetrica* Sars (1908).
First antennae of female reach the end of the furca ; thoracic processes turn back and reach one half the length of the genital segment *tenera* Sars (1912).

22. First antennae of female extend to the furca ; thoracic processes extend half the length of the genital segment ... ... *longiseta* Smith (1909).
First antennae of female extend to the end of the thorax or second abdominal segment ; thoracic processes extend to the second abdominal segment ; terminal spine of right fifth leg in male is cleft at the tip ... ... *pseudocheles* Searle (1912).

23. Second basal segment of male left fifth leg with serrate lamella extending beyond the tip of the endopod ... ... *delicata* Percival (1937).
This segment has no lamella 24

24. Thoracic processes extend nearly to end of furca *nyoraensis* Searle (1912).
Thoracic processes do not exceed the third abdominal segment 25

25. Inner surface of the basal segment of the right male fifth leg with a spine ; left fifth endopod is small and broad, its breadth being to its length as 5 : 6 ... ... *saycei* Sars (1908).
No spine on the basal segment of the right fifth leg ; the left endopod is small and narrow, its breadth being to its length as 3 : 5 ... *propinqua* Sars (1904).

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EXPLANATION OF PLATES.

PLATE I. *Boeckella opaqua*, n.sp.

Fig. 1. First antenna of male.

Fig. 2. Second antenna.

Fig. 3. Mandible.

Fig. 4. First maxilla.

Fig. 5. Second maxilla

Fig. 6. Maxilliped.

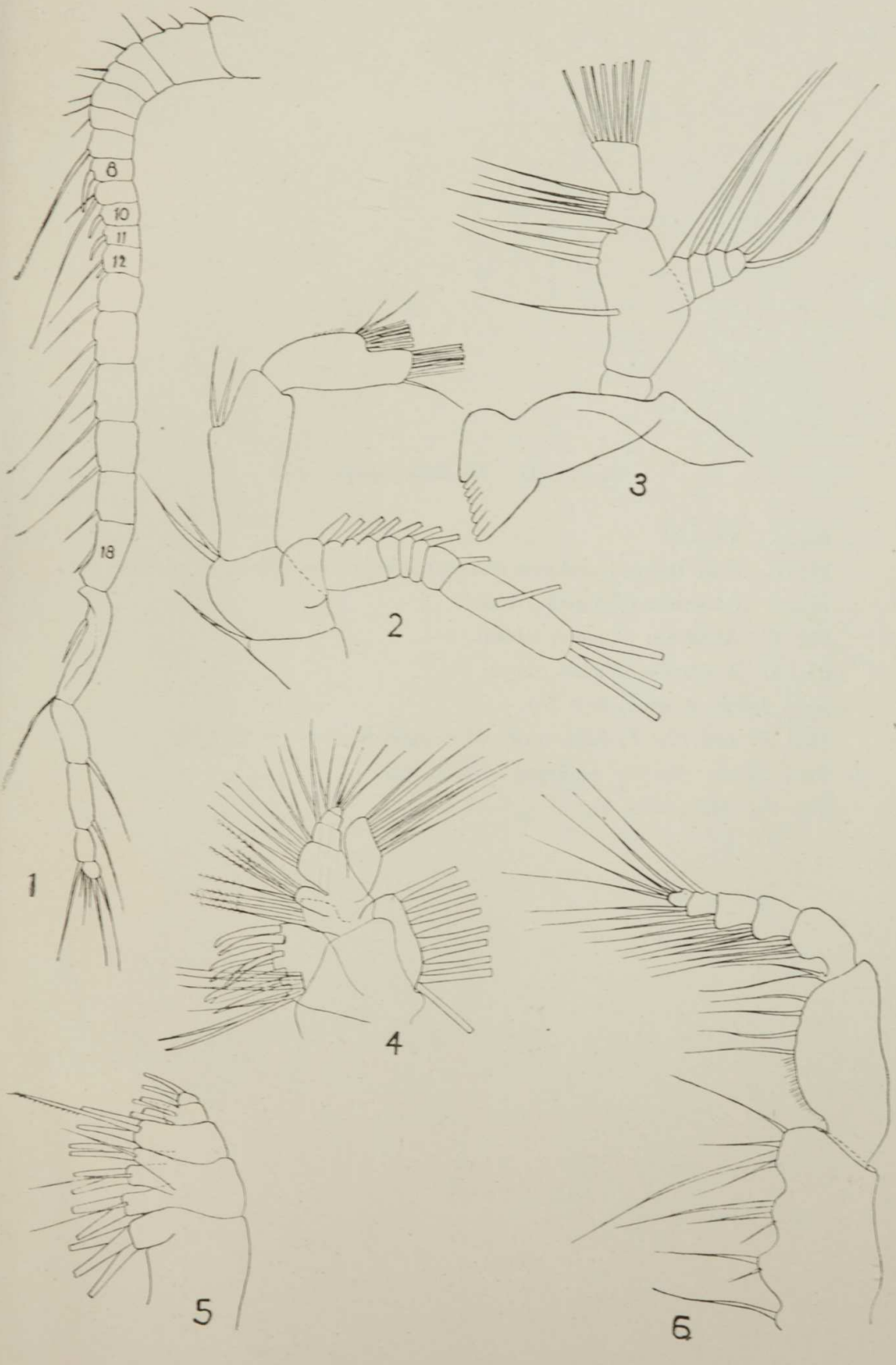
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PLATE II. *Boeckella opaqua* n.sp.

Fig. 1. Female.

Fig. 2. Fifth thoracic and first abdominal segments of female, from the left.

Fig. 3. Abdomen of female, dorsal.

Fig. 4. Abdomen of male, lateral.

Fig. 5. Abdomen of male, dorsal.

Figs. 6–10. Female, legs 1–5.

Figs. 11 and 12. Female, terminal exopod segment of fifth leg.

Figs. 13–15. Female, endopod of fifth leg.

Fig. 16. Male, fifth leg.

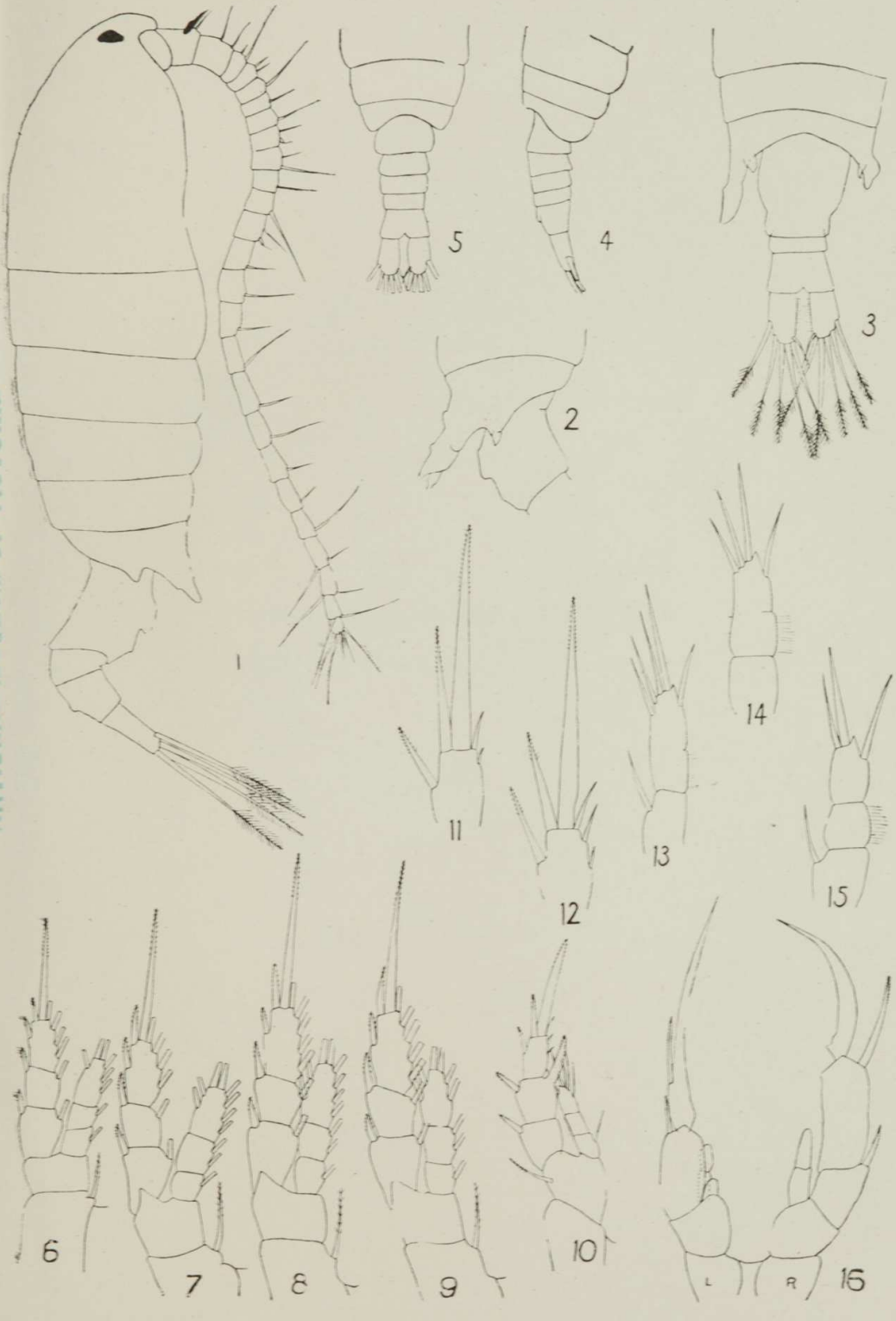

PLATE III. *Boeckella opaqua* n.sp.

Figs. 1–6. Nauplius stages I.–VI., lateral.

PLATE IV. *Boeckella opaqua* n.sp.

Figs. 1–6. First antenna of nauplius stages I.–VI.

Figs. 7–12. Nauplius stages I.–VI., ventral.

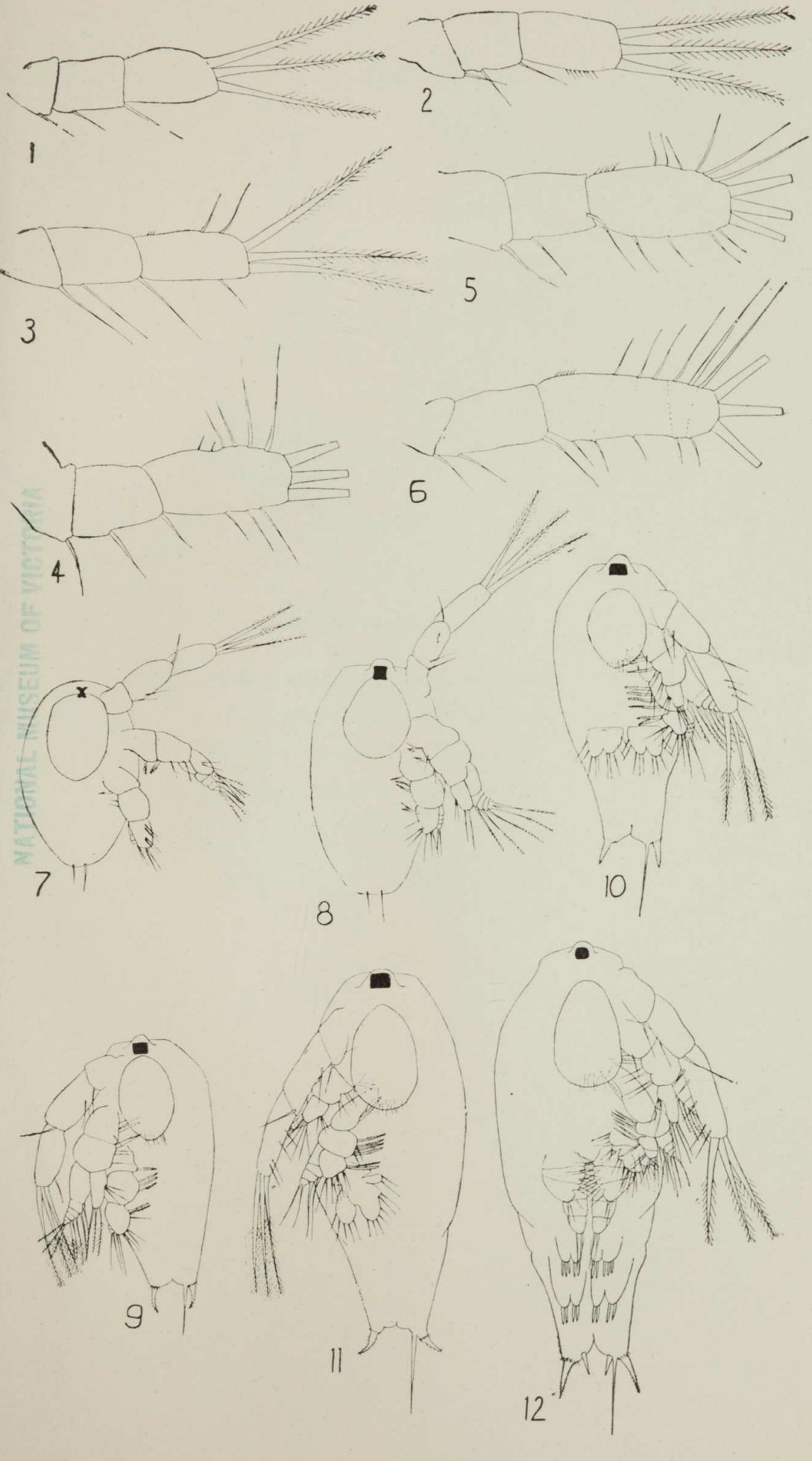

PLATE V. *Boeckella opaqua* n.sp.

Figs. 1–6. Second antenna of nauplius stages I.–VI.

Figs. 7–12. Mandible of nauplius stages I.–VI.

Figs. 13–15. First maxilla of nauplius stages IV.–VI.

Figs. 16. Second maxilla of nauplius stage VI.

Fig. 17. Maxilliped of nauplius stage VI.

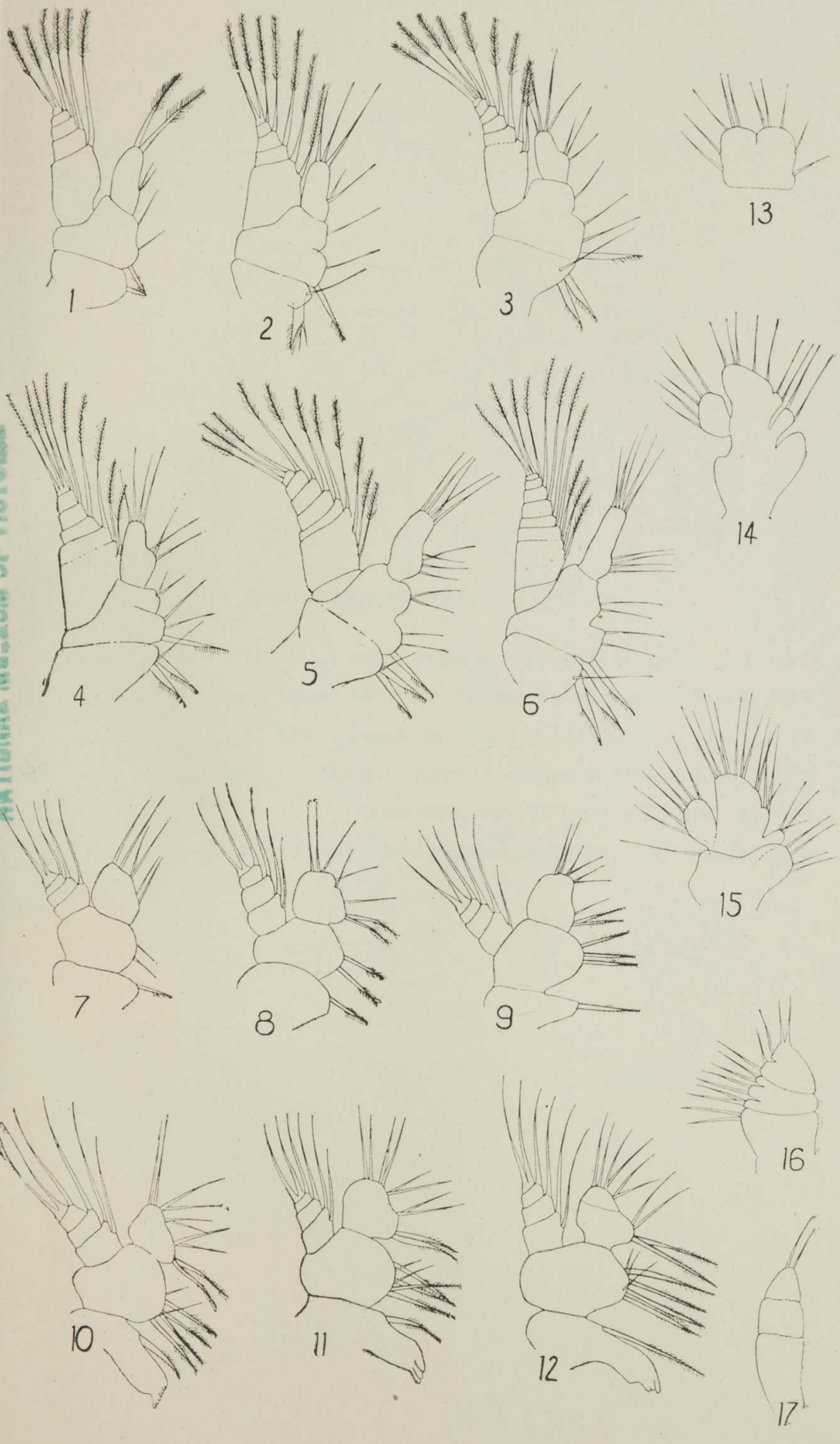

PLATE VI. *Boeckella opaqua* n.sp.

Figs. 1–4. First antenna of copepodid stages I., II., IV., and V. (male).

Figs. 5 and 6. Second antenna of copepodid stages I. and II.

Figs. 7 and 8. Mandible of copepodid stages I. and II.

Figs. 9 and 10. First maxilla of copepodid stages I. and II.

Fig. 11. Second maxilla of copepodid stage I.

Figs. 12 and 13. Maxilliped of copepodid stages I. and II.

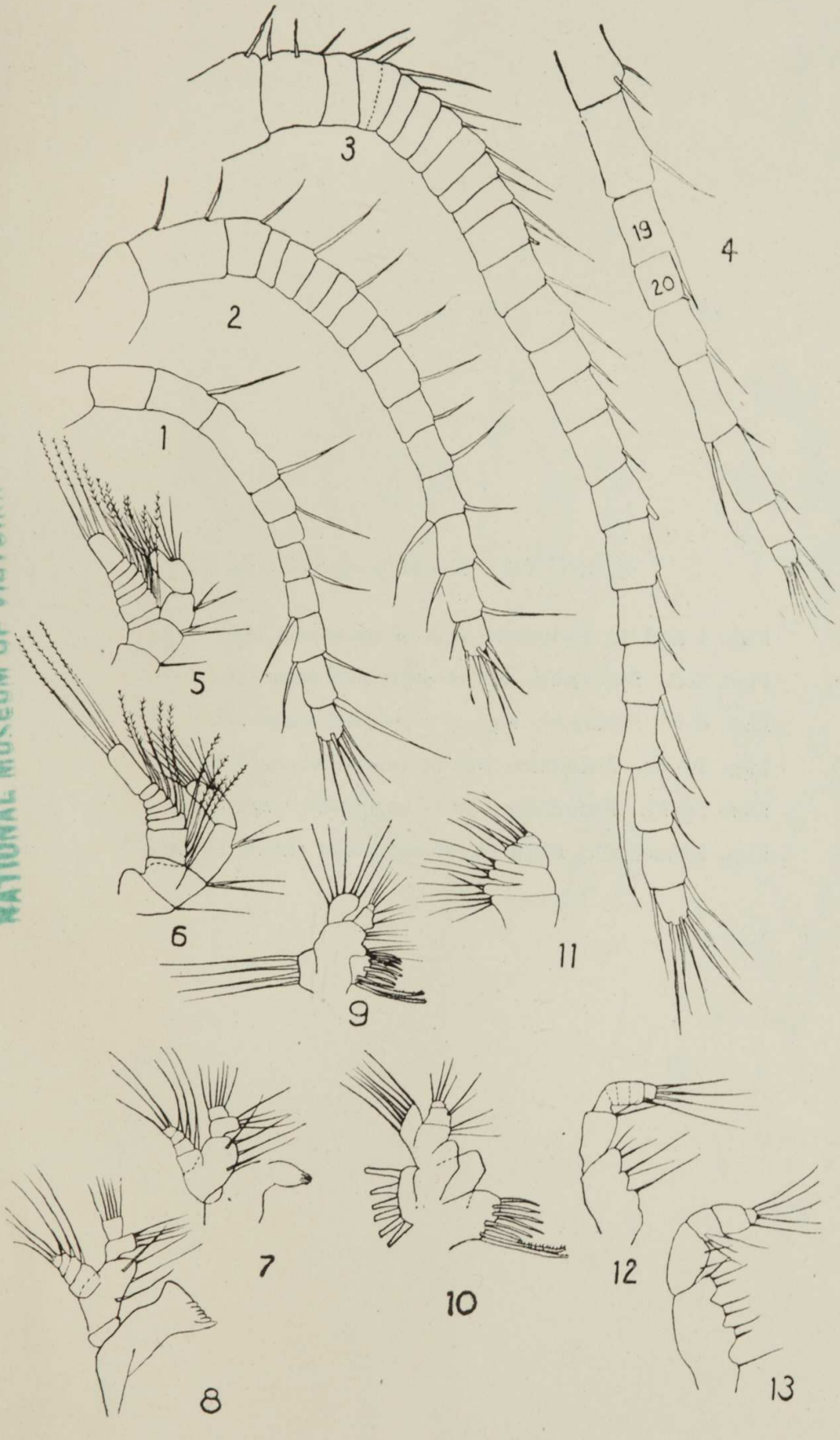

PLATE VII. *Boeckella opaqua* n.sp.

Figs. 1 and 2. Swimming legs of copepodid stage I.

Figs. 3–5. Swimming legs of copepodid stage II.

Figs. 6–9. Swimming legs of copepodid stage III.

Figs. 10–13. Swimming legs of copepodid stage IV.

Figs. 14–17. Swimming legs of copepodid stage V.

Figs. 18 and 19. Fifth leg of copepodid stages IV. and V.

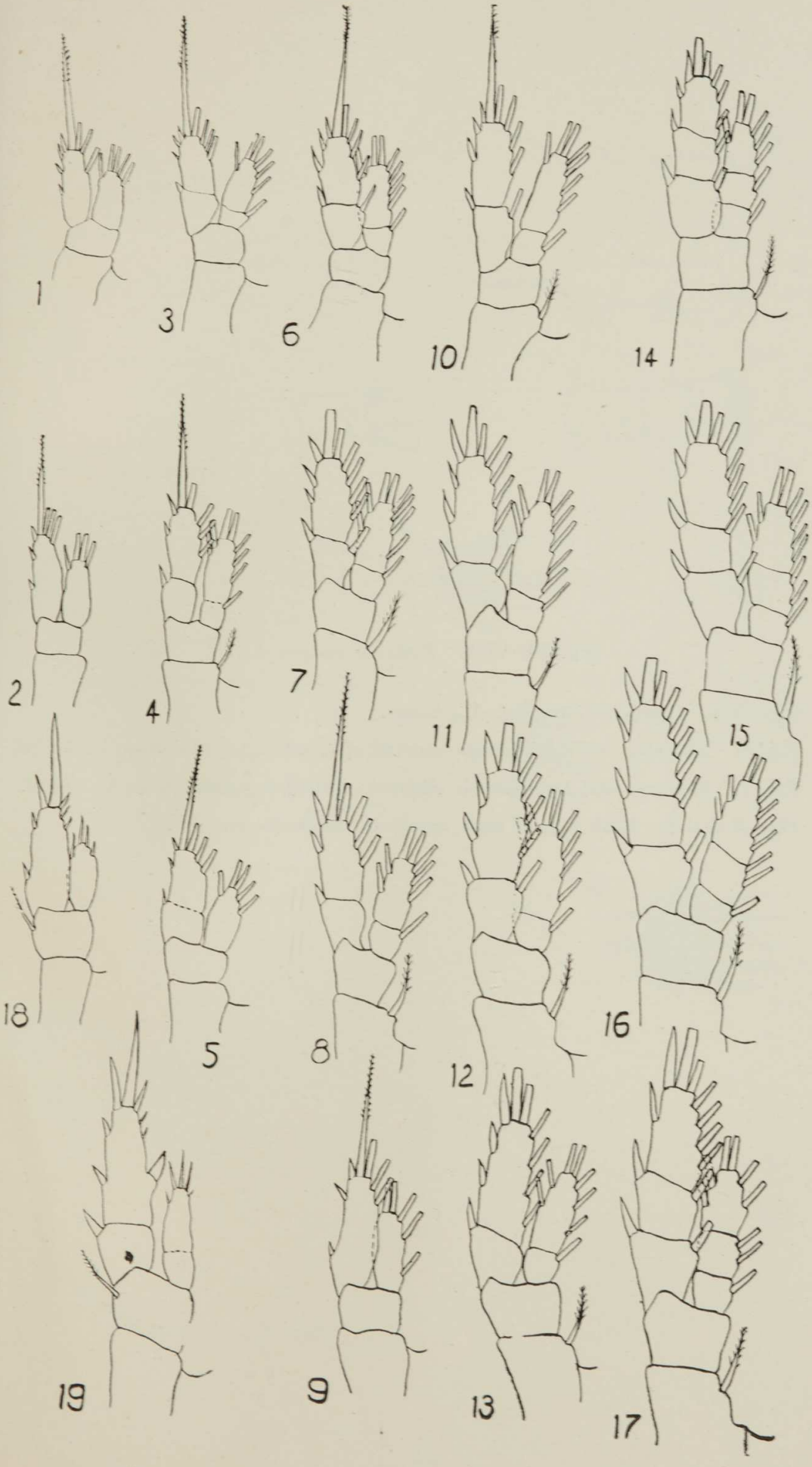
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PLATE VIII. *Boeckella opaqua* n.sp.

Figs. 1–5. Copepodid stages I.–V., dorsal.

Fig. 6. Abdomen and last thoracid segment of female copepodid stage V., lateral.

Fig. 7. Abdomen and last thoracic segment of male copepodid stage V., dorsal.

Figs. 8 and 9. Fifth legs of male copepodid stages V. and IV.

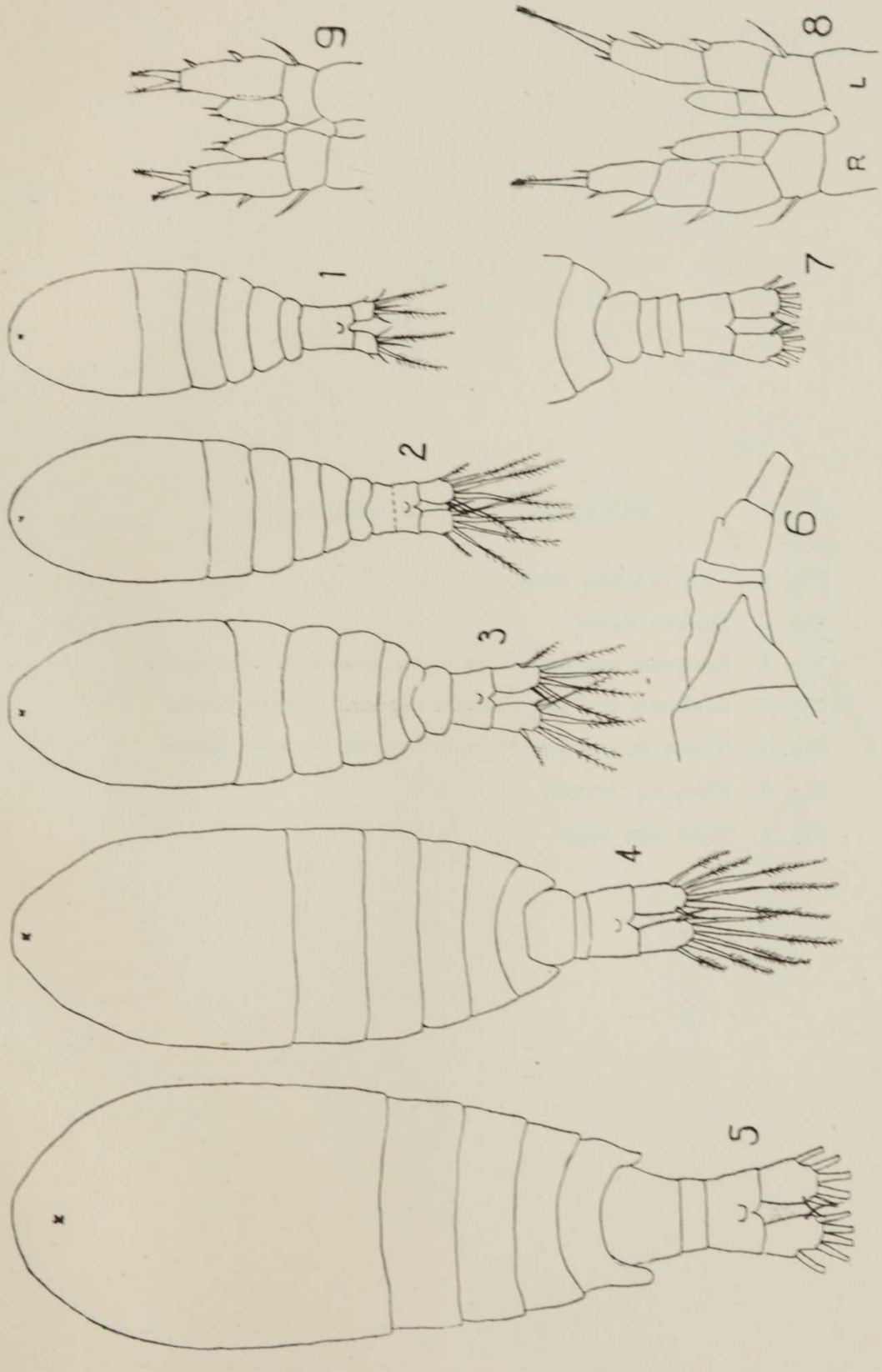
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PLATE IX. *Boeckella pellucida* n.sp.

Fig. 1. First antenna, male.

Fig. 2. Female, dorsal.

Fig. 3. Abdomen and last thoracic segment of female, lateral.

Fig. 4. Abdomen and last thoracic segment of male, dorsal.

Fig. 5. Abdomen and last thoracic segment of male, lateral.

Fig. 6. Fifth leg, female.

Fig. 7. Fifth legs, male.

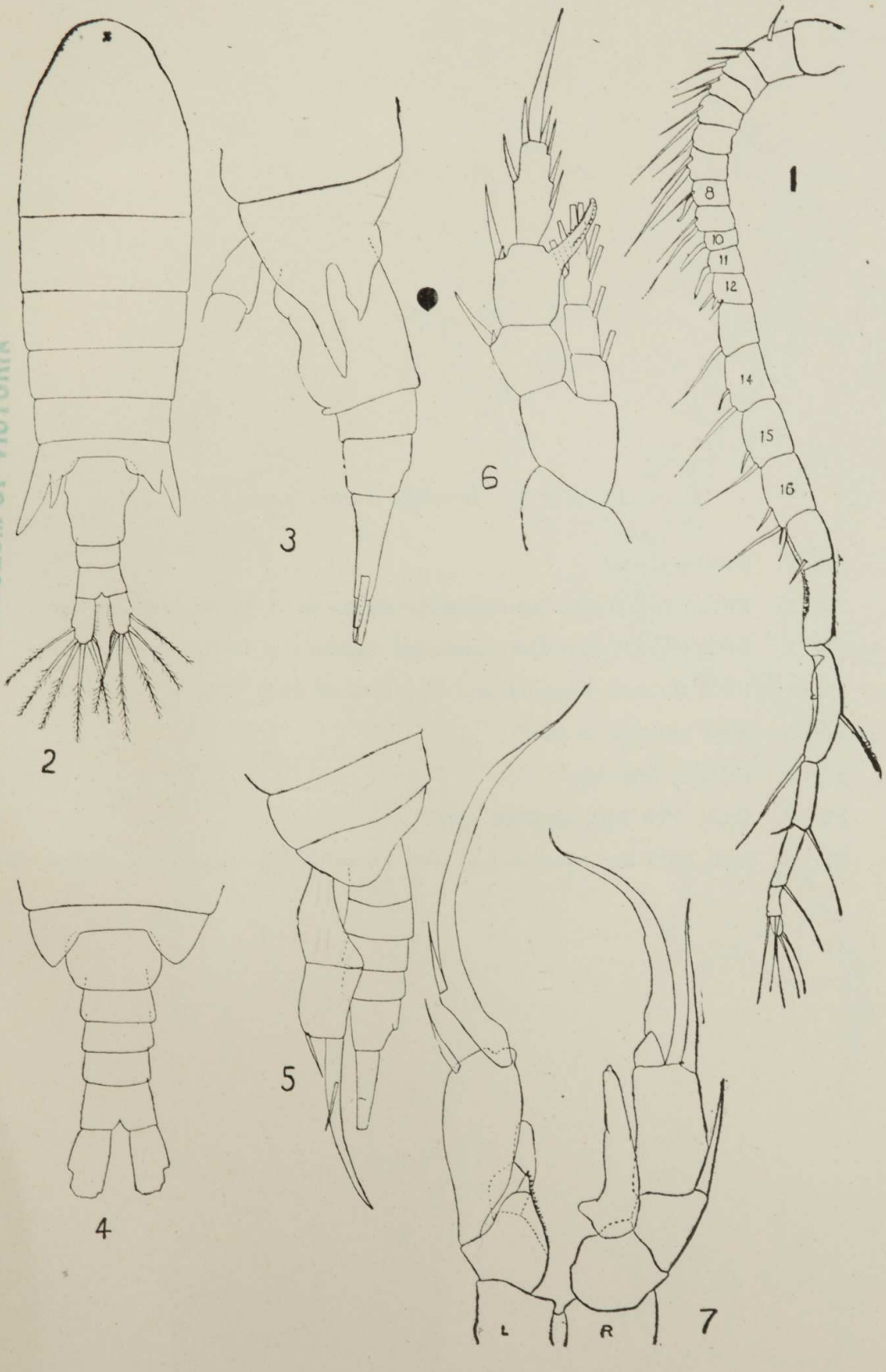


PLATE X. *Boeckella lacuna* n.sp.

Fig. 1. Female dorsal.

Fig. 2. Fifth thoracic and first abdominal segments of female, from the right.

Fig. 3. Fifth thoracic and first abdominal segments of female, from the left.

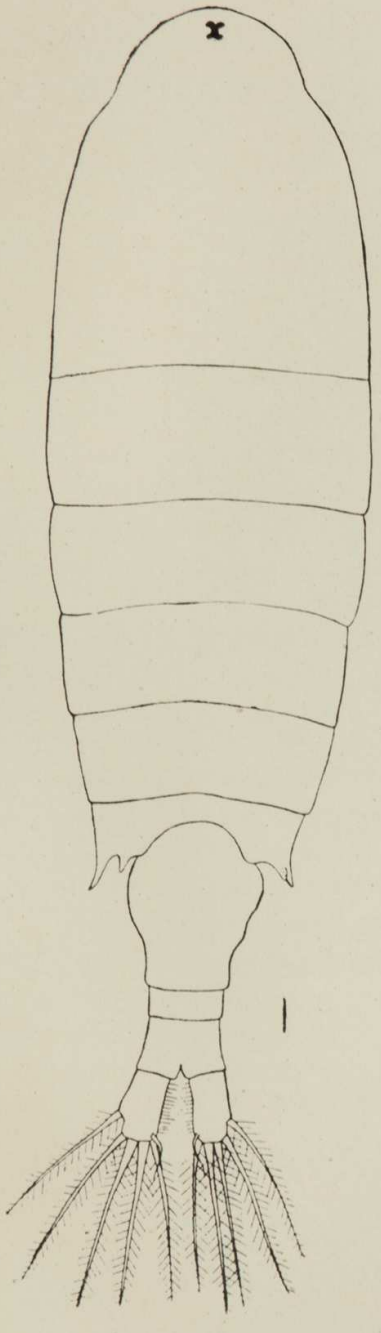
Fig. 4. Fifth thoracic segment and abdomen of male, dorsal.

Fig. 5. First antenna of male.

Fig. 6. Female, fifth leg.

Fig. 7. Male, fifth legs, anterior view.

Fig. 8. Male, fifth leg, left endopod, and second basipod lamella posterior view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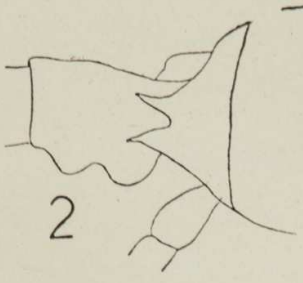
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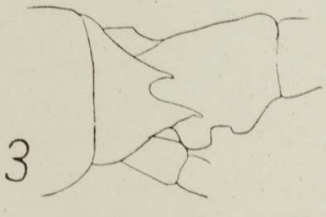
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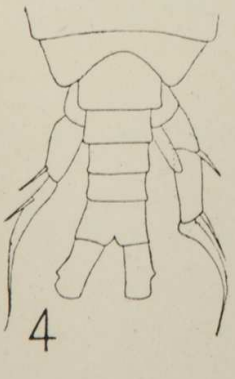
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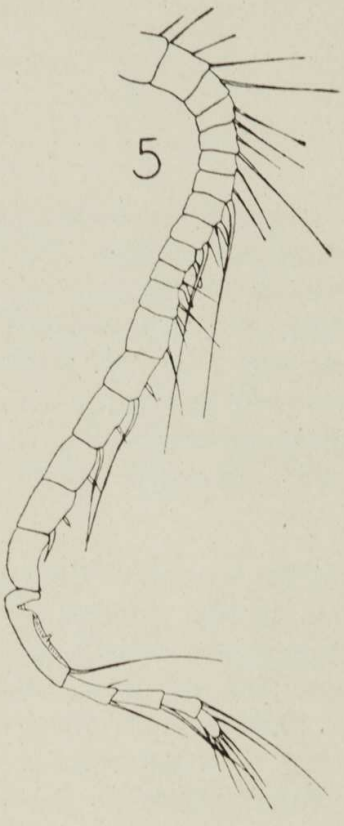
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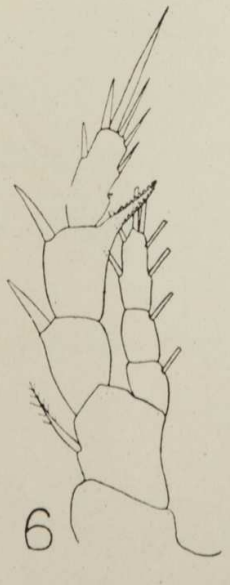
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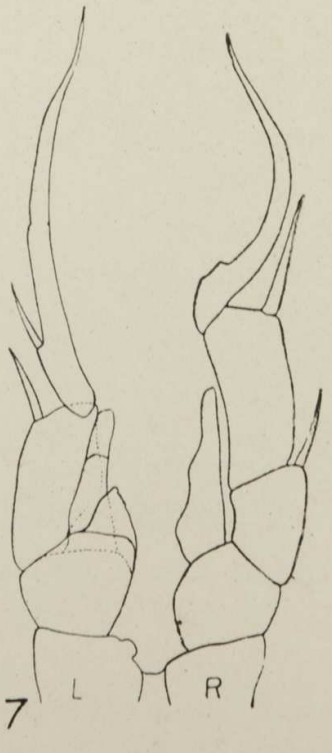
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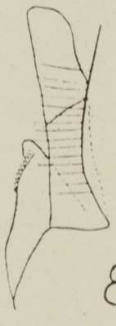
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